IGSI

UNIT - 12

CHEMISTRY FOR CLASS IX

POLLUTION AND ITS EFFECTS ON THE LIVING WORLD

राष्ट्रीय शैक्षिक अनुसंधान और प्रशिक्षण परिषद्
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PREFACE

The present series of twelve chemistry units has been developed for try-out of the Individually Guided System of Instruction (IGSI) in class IX. The description of IGSI and first two units of this series of units are available under a separate cover. This new system of instruction and the units have been developed along the lines of the National Policy on Education (NPE-86) and involve the participation of pupils in the process of learning. The units are suited for self-study with occasional help from a tutor. In the present context, these units will serve as examplar self-study material for secondary stage chemistry. In developing this unit, I was assisted by some of the chemistry teachers.

This unit contains an introduction for motivation, arousing interest, and to link the present unit with preceeding and next units. The objectives given in this unit are the expected learning outcomes, so that the pupil will know the ultimate goals he has to achieve. The suggested reading material provided in the unit guides the pupil to achieve pre-stated objectives. A number of intext and post-text questions, activities, and problems have been included to provide enough practice and chance for self evaluation.

The suggestions for the improvement of this unit will be welcomed.

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I Introduction

Whenever we travel in an overcrowded bus or when we are in some crowd, we feel suffocated. On a hot summer day, when we leave the walled city and go in a green field, garden or to sea-side, we say how good the air is. We talk about 'fresh air'. A stinking smell coming from a nearby place or the smoke coming from a kitchen, from an industry, or from a railway engine makes our breathing unpleasant. We feel uneasy in such a situation and tend to go in the open to get fresh air. In the year 1984, a poisonous gas 'methyl isocyanide' from Union Carbide factory in Bhopal, leaked into the atmosphere, This resulted in a large number of casualities in Bhopal.

Just like air, clean water is also a primary support for the sustainance of life. Water is used by human beings as well as by plants. Use of uncleaned water causes various diseases such as typhoid, dysentry, cholera etc.

In addition to air and water, we require good quality of food. A good quality of food can be grown only on a good quality of soil. In this unit, we shall study the ways in which air, water and soil get spoiled (polluted) We shall also study the harmful effects of the presence of various undesired materials in air and water and the measures to control them.

II. Objectives

After studying this unit, you should be able to

(1) State the constituents of dry air.

(2) State how man's activities introduce various harmful substances in the environment.

(3) Explain the causes of pollution.

(4) List various sources of air pollution.

(5) State harmful effects of air pollutants.

(6) State the steps required to control air pollution.

(7) List sources of water pollution.

(8) State harmful effects of water pollution.

(9) State the steps required to control water pollution.

(10) State the causes of soil pollution and the steps to control it.

12.1 Air in the Environment

Air is essential for all ·- Air is essential for the survival of all living organisms. It supplies oxygen to our bodies. In fact the life does not exist on Moon and Mars because of the absence of air on these planets. Air has no bounding lines. It moves from one place to another very fast. It is a mixture of a number of gases. The composition of various gases in clean and dry air is given in Table-12.1.

Table - 12.1

Name of gas	Percentage by volume
Nitrogen	78.09
Oxygen	20.95
Argon	0.93
Carbon dioxide	0.03
Neon	0.002
Helium	0.0005
Methane	0.0002

We can see from Table - 12-1 that three gases, namely nitrogen, oxygen and argon, make up 99.97 percent of dry air. The composition of water vapour present in air is not included as it varies from place to place and from season to season. The composition of air changes when other gases (sulphur dioxide, carbon dioxide etc.) and solid particles released from various sources are added to it. The air then becomes polluted. We may note here that certain unwanted gases like carbon dioxide and methane are already present in air in very small concentration. If the concentration of these gases increases in air, they become harmful.

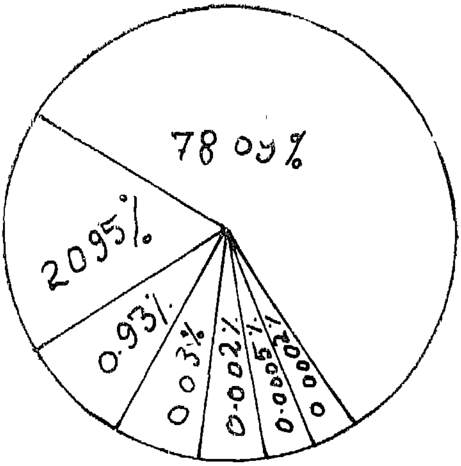

Fig. 12.1 Composition of air.

Activities

1. Put a cockroch in an air tight box. Open the box after about 10-15 minutes. Notice what happend to the species inside the box ?

2. Light an agarbati in one corner of the room and observe its fragrant smell in another corner after a few seconds.

Question

Name the gas which is present in maximum amount in air ?

12 2 Pollution

We know that while breathing, we inhale oxygen and breathe out carbon dioxide and that we feel suffocated if we breathe in an atmosphere of carbon dioxide. Thus we are adding carbon dioxide into the air every moment Carbon dioxide is also being added into the atmosphere by other sources like various industries, combustion of fuel, automobiles etc. Have you, therefore, ever thought where does the carbon dioxide released into the atmosphere from various sources go ? Nature helps us in this. Nature has provided a wonderful process of removing this harmful gas through plants. Plants absorb carbon dioxide from air and in turn leave oxygen. But plants can absorb carbon dioxide only to a certain limit. They do not have the infinite capacity to absorb this gas. Therefore a balance between the rate of release of carbon dioxide and its absorption by nature, known as '*nature's balance*' is necessary. This will avoid an increase in the concentration of pollutants in atmosphere. Just like carbon dioxide, there are other gases, namely sulphur dioxide, certain chemicals in water etc, whose increase of concentration in air or in water are very harmful.

The increase of concentration of harmful materials in the environment (land, air & water) by a disturbance of nature's balance over them is known as *pollution* The harmful materials are known as pollutants.

Pollution results mainly due to the discharge of an excess of waste material (solid waste, gases, toxic material, etc) from homes, industries, automobiles etc into the environment. Pollution of the environment is not only due to the material substances. It may also result due to non-material substances such as an excess of light and noise

Activities

1. List the common pollutants of air and water in your locality.
2. Breathe out through a simple tube (glass or rubber) into 1 cc of clear lime water and observe.

   Turning of lime water milky indicates that we breathe out carbon dioxide.

The smoke consists of particles of unburnt or partially burnt fuel and *particles* of non-combustible material in the fuel The burning of fuel releases particles described above and invisible gases. These gases are carbon dioxide, carbon monoxide, sulphur dioxide and nitric oxide. The particles and the gases both in the fuel are havier than Air. Their concentration therefore becomes more near the surface of earth and we are forced to inhale them.

Petrol contains lead compounds in it Therefore the exhaust gases from automobiles contain lead particles along with the oxides of carbon.

Another source of air pollution is the release of harmful material from certain industries. For example, paper industry adds a stinking smell to air, the smoke coming out from chemical industries may carry certain toxic chemicals with it. The removal of green plants which purify air, also adds to the problem of air pollution.

Activities

1. List the various sources in your locality that release smoke into the air.
2. What are the main constituents of smoke ?
   (i) Light a candle or a kerosene lamp

   (ii) Hold a sheet of white paper slightly above the flame.

   keep it sufficiently away from the flame, otherwise it will burn. Do you find any deposit on the paper ?

   Smoke consists of carbon particles

Question

1. What are the sources of air pollution ?
2. What does smoke contain ?

12.32 Harmful effects of air pollution

The harmful effects of pollutants depend on their concentration in air. The concentration of pollutants is expressed in parts per million (ppm). It is the number of molecules of pollutants in one million molecules of air.

The air pollution effects human health, plants and trees in a number of ways Air pollution also affects paints, it blackens buildings, corrodes metals and crumbles marble.

The harmful effects of pollutants in air depend upon their concentration. We have studied that smoke, the major air pollutant, consists of carbon particles and various gases. These gases are carbon dioxide, carbon monoxide, sulphur dioxide, and nitric oxide. The smoke released from chemical industry may carry with it vapours of chemicals like lead, mercury, bromine, silica etc. These chemicals are very harmful and cause respiratory trouble, skin diseases, and nervous disorders. These chemicals along with carbon particles may get deposited on our food and poison it. The use of this food may affect various systems of our body.

Carbon dioxide is added to air by burning of fuels and by all living organisms. The increase in concentration of this gas in air extinguishes the flame. The living organisms may also die. Carbon monoxide is a more serious air pollutant It is produced by combustion of fuel in insufficient supply of oxygen. It is present in fumes released by automobilies. If inhaled, carbon monoxide reduces the amount of oxygen in blood. At higher concentration of carbon monoxide, the mental performances may become dull.

Sulphur dioxide in air comes mainly by burning of coal in thermal power plants. These power plants burn coal of high sulphur content for generating steam. The steam in turn runs turbines. Sulphur dioxide gets converted into sulphurous acid when it comes in contact with a wet surface. The inhalation of sulphur dioxide and sulphurous acid vapours cause injury to respiratory system. The acid vapours may also cause corrosion resulting in damage of property.

Nitric oxide is produced in high compression engine from nitrogen and oxygen of the atmosphere. It affects the supply of oxygen through blood much in the same way as carbon monoxide does. It also increases children's suseptibility to influenza.

Ozone layer : About twenty-five kilometres from earth's surface, ozone is formed by the action of ultraviolet light on oxygen.

$$\underset{\text{Oxygen}}{3O_2} \longrightarrow \underset{\text{Ozone}}{2O_3}$$

The ozone layer filters out the ultraviolet light. This light can damage living systems. The ozone layer gets disturbed by high flying surface jets

Questions

1. Match gases in column I with items in column II

Column I	Column II
Carbon monoxide	Smog
Nitrogen oxides	Supersonic jets
Sulphur dioxide	Oxygen in blood
Ozone layer	Acid rain

2. Match gases in column-I with their source in column-II

Column-I	Column-II
Carbon monoxide	Coal burning
Sulphur dioxide	Automobile exhaust
Nitrogen oxides	Combustion in insufficient air

3. Air pollution is found more in big cities compared to towns or villages. Explain the above statement giving reasons.

12.33 Control of Air Pollution

The air pollution is a serious problem in big cities due to a number of industries, burning of large amount of fuel in homes, automobiles etc. In rural areas there are only few houses and the smoke gets dispersed in air. Air pollution can be controlled by using various devices. Plants play an important role in controlling air pollution. They purify air. In the automobiles certain devices should be used so that the fuel burns in free supply of excess of air. This would minimise the release of carbon particles and carbon monoxide gas in the exhaust gases of automobiles. In the chimney of big industries, a device known as *electrostatic precipitator* is used to retain the smoke particles. Proper collection and disposal of city garbage also helps to control air pollution.

12.4 Water in our Environment

12.41 **Water is essential for life :** Just like air, water is also a vital factor for our life. A person can exist without air for a few minutes and without water for a few days only. We require water for drinking, cooking, irrigation, etc. water is used in hydro-electric plants for generating electricity. Almost all heavy industries such as steel, paper, jute, etc require a huge amount of water. Water has a distinctive characteristic of readily changing from solid to gas and back again It is due to this property that water from oceans, reserviors, and pônds evaporates easily. During evaporation, water absorbs the heat of the surroundings and cools the land.

Activity : Show that plants contain water.

(i) Take a plant out of soil along with its roots.

(ii) Weigh it accurately and make a record of its mass.

(iii) Dry it in Sun for several days and weigh again.

Do you notice any change in initial and final masses ?

12.42 **Sources of water** ; Water is very abundant on the earth's surface but it is not evenly distributed. Rain, springs, rivers, ground water, lakes and oceans are the common sources of water. However the water of the ocean is not directly usable due to the large concentration of salt and other minerals in it. A process of distribution of water from oceans is through rains Water evaporates from oceans and then rain accomplishes the distribution. As the rain falls, some of the water is soaked in the ground while some runs-off immediately. The water soaked in the ground passes through a natural filter bed and becomes our underground water source.

The water which runs-off through slopes accumulates in ponds and rivers We get water from these sources. These should therefore be kept neat and clean and should be protected from pollution.

Activity : Filter a sample of muddy water.

(i) Punch a number of small holes in the bottom of a box.

(ii) In the box, pour in about 2 cm gravel upto about 2 cm height and sand on gravel upto 2 cm height.

(iii) Rest the box on an empty glass tumbler. Pour some muddy water on top of sand and let it filter through.

You will see that filtered water is clear. But it may contain germs. Boiling this water kills the germs.

2.43 **Sources of water pollution** : Water gets polluted in a number of ways. The containers, we use for keeping water, if not properly cleaned, will be contaminated with germs of various diseases. Washing he clothes and releasing the dirt in the water source, well or a pond, pollutes water. In the villages, the waste water if discharged near a well or a pond may pollute water of these sources The agricultural wastes also contribute to the problem of water pollution. The fertilizers from a highly fertilized land may be drained off by rain in a pond or a lake. The chemicals used as fertilizers may also create conditions in the pond which removes oxygen from water. Great quantities of water are used to remove sewage and wastes from our houses, schools, industries and other places of work. This sewage and industrial waste water is usually discharged in the pond or river located nearby The cities and factories located along rivers use the river as a dumping place for waste water and waste material. This may also cause pollution of water. This pollution may effect communities further downstream which may use the river as a source of drinking water. The discharge from sewage contains mainly organic matter, chemicals and suspended solids. The organic matter decomposes in the sewage in presence of bacteria. In this process, the bacteria use oxygen dissolved in water. The minimum amount of oxygen required for decomposition of sewage water is known as Biochemical Oxygen Demand (BOD). Thus oxygen dissolved in water becomes less The removal of oxygen from water is known as *Eutrophication*. It affects the aquatic life and fish.

The removal of plants and trees also affects our water resources. The plants and trees help to hold the top soil of the earth. The top soil has the capacity to retain the water on the surface. If the top soil is removed, water will quickly go underground. The wells, rivers, ponds, etc. will soon become dry. During the rainy season, in the absence of top soil, more water will rush into rivers and ponds. This will cause floods.

Sea-water gets polluted by spilage of oil. We know that oil is transported from one country to another by ships. The leakage of oil from these ship-tankers causes the pollution of sea water.

Questions

1. How does water in ponds, rivers and sea help to cool the land ?
2. Ocean is a big reservoir of water. How is then water from the ocean distributed to different parts of earth ?
3. Why is it not possible to use the sea-water directly for drinking, cooking and irrigation purposes ?
4. What are the various sources of water ?
5. Write about the various sources of pollution of water.
6. Define the term eutrophication. What are its harmful effects ?
7. How are our water resources affected by the removal of top soil ?

12.44 **Harmful effects of water pollution :** Water Pollution is a great hazard and affects the living organisms, aquatic life, agriculture, wild life and industries. Diseases such as amoebiasis, typhoid, paratyphoid, hepatitis, cholera, gastroentitis etc. are caused by using polluted water. The decrease of oxygen content of water in a pond or lake as a result of eutrophication affects the aquatic life The fish can not survive in such conditions. The water becomes cloudy and gives foul odour. Polluted water if used for irrigation may harm the plants.

12.45 **Control of water pollution :** The problem of water pollution is very serious and its control is very essential. Water pollution is a more serious problem in cities then in villages. Plants play an important role for prevention of water pollution. Plants help to hold the top soil. The grass, plants and trees hold a large amount of water. Thus the flow of water into rivers is lessened and floods are prevented.

In big cities, industrial waste is discharged into main stream of river. This industrial waste may be acidic or alkaline in nature. This makes river water unfit for drinking. Therefore the industrial waste should be given a proper chemical treatment before dumping into main stream.

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For example, if the waste is acidic in nature, it must be treated with calcium hydroxide. This treatment is known as chemical treatment.

The sewage water may be passed through a septic tank containing sand and gravel filters (Figure 12.2). The sewage water thus passed becomes odourless and colourless water

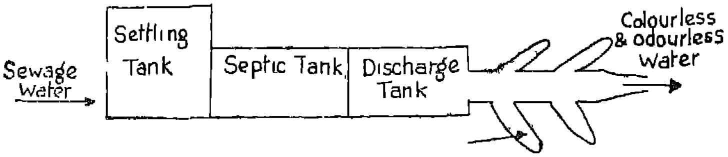

Fig. 12 2

Biochemical oxygen demand (BOD) of sewage waste and eutrophication may be controlled by using some aerobic bacteria. Use of excess fertilizers should be avoided because unused nitrate ions and phosphate ions are washed into rivers and lakes.

12.5 Soil Pollution

We also require food for our survival. Increasing population of the world is becoming a major problem. We have increased our crop yield by using good quality of fertilizers and chemicals. But excessive use of fertilizers without judicious scientific basis for deciding about the type and quantity of fertilizers to be applied to the soil leads to the detereoration in the conditions of the soil. This is known as soil pollution

When any fertilizer is used repeatedly for getting better crops, some of the ions are left behind. These tend to pollute the soil. For example, sodium nitrate or potasium nitrate provides Na^+, K^+ and NO_3^- ions. The nitrate ions are used by crop. The Na^+ and K^+ left in the soil make it alkaline. Similarly if $(NH_4)_2SO_4$ is used in excess, NH_4^+ ions are used up by crops. The sulphate ions are left behind and make the soil acidic.

Acid rain : When fossil fuels are burnt, a large amount of CO_2 & SO_3 (oxidation of SO_2) enter the atmosphere. The gases CO_2&SO_3 dissolve in water to produce carbonic acid and sulphuric acid respectively Sulphuric and carbonic acids are removed from the atmosphere during rain This is called acid rain. The pH of acid rain water is 4 to 5. Acid rain can effect lungs, pigments of green plant, marble etc Due to the presence of these acids in rain, the soil becomes toxic for Plant growth

Use of Insecticides and Herbicides : Insecticides and herbicides are poisonous chemicals They are sprayed on standing crops to kill insects, fungi, rodents etc. These chemicals may enter in the living tissues of the growing plants and accumulate in the grains or fruits When we eat such grains or fruits, these poisonous chemicals would enter in our body and may damage our health.

I V. Home Assignment

Carry out the activities suggested in the unit.

V. Self Assessment

1. What is pollution ? How do the crowded cities contribute to the pollution of air and water resources.
2. What is meant by the term nature's control ? How is it related to pollution ?
3 Pollution of water may lead to pollution of air; Justify.
4. We feel pleasure when we go out of the crowded city to a country side because
   (i) We have a change.
   (ii) We have fresh and unpolluted air to breathe.
   (iii) the air of the place contains oxygen only.
   (iv) none of the above.
5. Air pollution due to the presence of carbon dioxide is because of
   (i) the presence of carbon dioxide in air.
   (ii) the increase of carbon dioxide concentration in air.
   (iii) the decrease of carbon dioxide in air.
   (iv) none of the above.

6. Eutrophication of pond water

   (i) increases the oxygen content of water

   (ii) decreases the oxygen content of water

   (iii) does not change the oxygen content

   (iv) increases nitrogen in water.

7. (a) Name the various substances that pollute air

   (b) How does SO_2 gas act as an air pollutant ? What are its harmful effects ?

8. Pollution is a problem in crowded cities then in agricultural predominating region, comment;

9. Name a gas which results when coal or oil are burnt in partial supply of oxygen. What are its harmful effects ?

10. How does nature help to control the concentration of carbon dioxide in air ?

11. Match the correct answer.

(a) Fresh air is essential	(i) causes pollution
(b) The increase of concentration of harmful materials into the environment is due	(ii) to the combustion of fuel in insufficient supply of oxygen.
(c) The increase of concentration of carbon monoxide in air	(iii) to maintain a good health
(d) The damage to respiratory system is caused due	(iv) to the intake of sulphur dioxide.

Teacher's Guide

The present unit deals with different kinds of environmental pollution due to the disturbance of nature's balance, harmful effects of pollution and finally prevention of pollution. The unit may be divided into the following main conceptual points These may be briefly elaborated in the class.

1. There is a balance among the various living forms and their environment called ecological cycle. The various forms of life exist in equilibrium

2. Concentration of human population in big cities produces large amount of waste This waste disturbs the ecological cycle. If proper steps of treating domestic sewage are not taken, it will affect plant and animal life.

3. Industrial activity of man introduces many pollutants into the environment. These pollutants in long term may endanger human life itself.

4. Large scale use of transport by automobiles increases air pollution. Most of the large cities in India have fog during winter.

5. Government has enacted laws to control air and water pollution.

The visit to any one or more of the following places located nearby may be arranged.

(1) Water supply unit

(2) Sewage treatment plant

(3) Thermal power plant

(4) Any chemical or textile factory.

The pollution at these places and the measures of its control may be discussed.